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(54) **INTRAMEDULLARY NAIL AND PROTRUDING SCREW LOCKING MECHANISM**

(75) Inventors: **Tom Overes**, Langendorf (CH); **Silas Zurschmiede**, Grenchen (CH); **Simone Volzer**, Solothurn (CH); **Robert Frigg**, Bettlach (CH)

(73) Assignee: **Synthes USA, LLC**, West Chester, PA (US)

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Related U.S. Application Data

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(51) **Int. Cl.**

A61B 17/56 (2006.01)
A61B 17/58 (2006.01)
A61F 2/30 (2006.01)

(52) **U.S. Cl.**

USPC **606/62**; 606/64

(58) **Field of Classification Search** 606/62–68, 606/250–251, 300–321, 329

See application file for complete search history.

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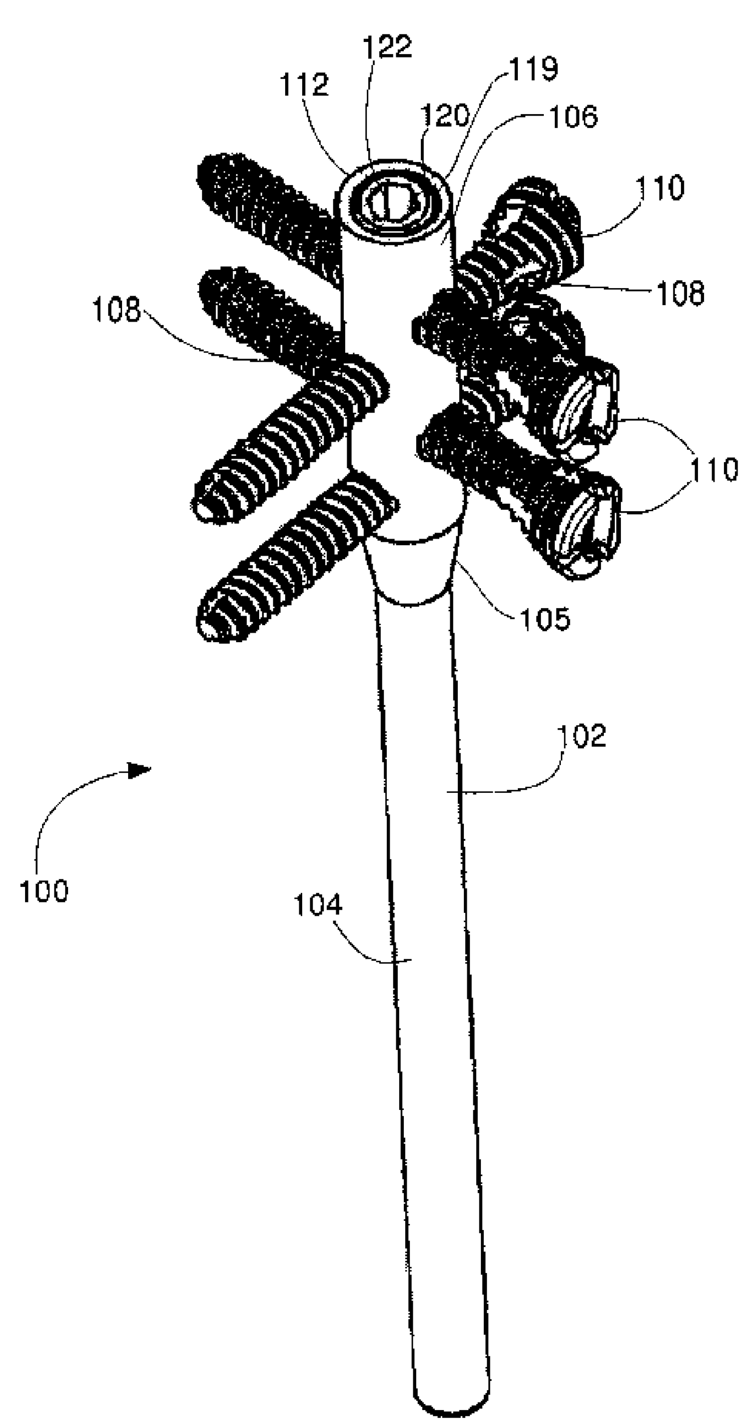
Primary Examiner — Eduardo C. Robert
Assistant Examiner — Christina Negrellirodriguez
(74) *Attorney, Agent, or Firm* — Fay Kaplun & Marcin, LLP

(57) **ABSTRACT**

An apparatus for treating a bone comprises an implant to be received within the bone, including a plurality of bores extending therethrough and a cavity formed therewithin, each of the bores being dimensioned to receive a bone fixation element and a plurality of inserts receivable in the cavity. Each insert includes an opening extending therethrough and configured to align with a corresponding bore. Each insert is movable between a resting configuration in which an opening width is smaller than a width of a bone fixation element inserted therethrough and a stressed configuration in which the opening width is expanded to a width greater than that of the bone fixation element in combination with a compression member movable into the cavity to apply a force moving the inserts from the resting configuration to the stressed configuration, withdrawal thereof reducing the force and permitting a return to the resting configuration.

19 Claims, 7 Drawing Sheets



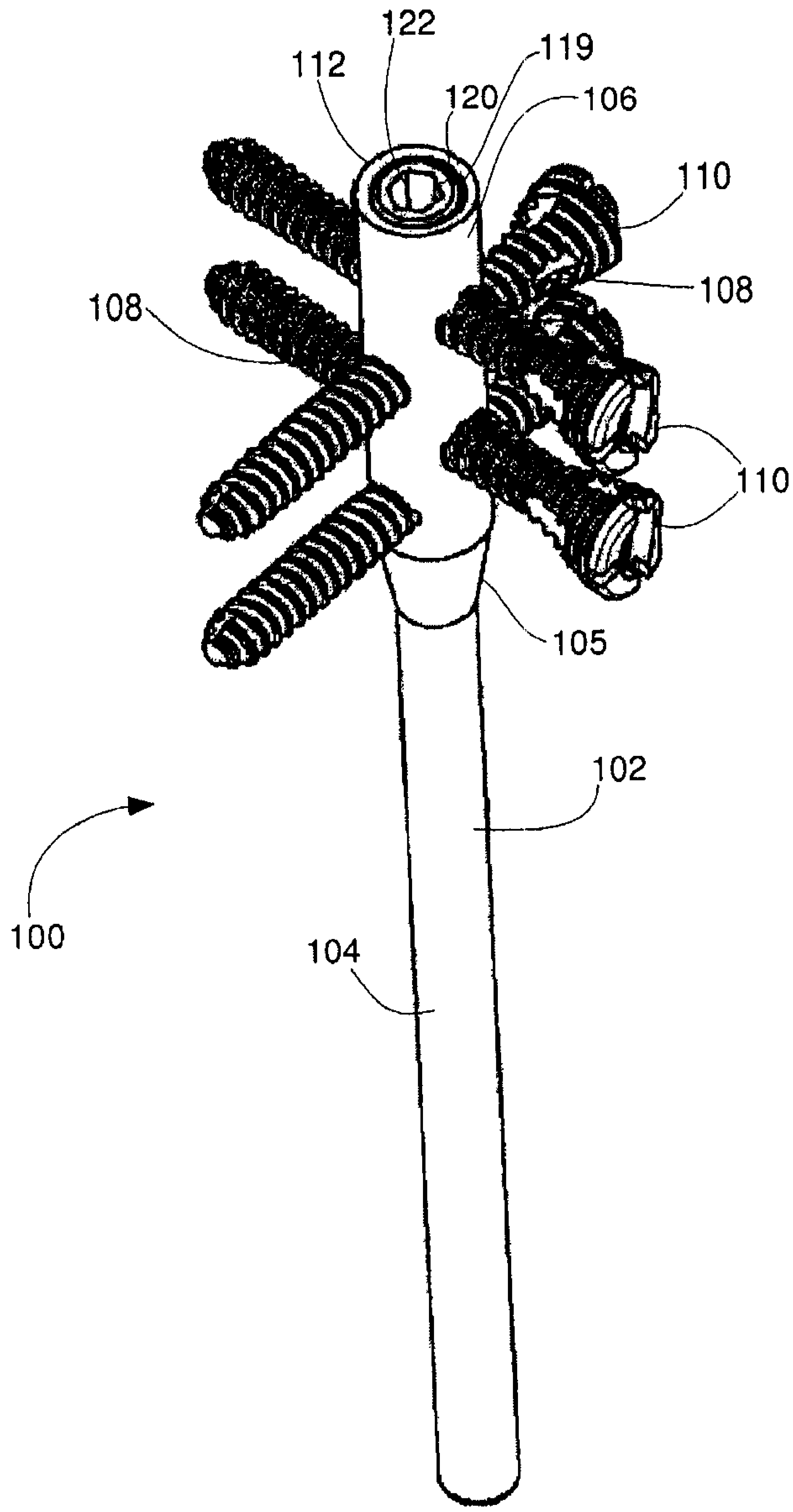


FIG. 1

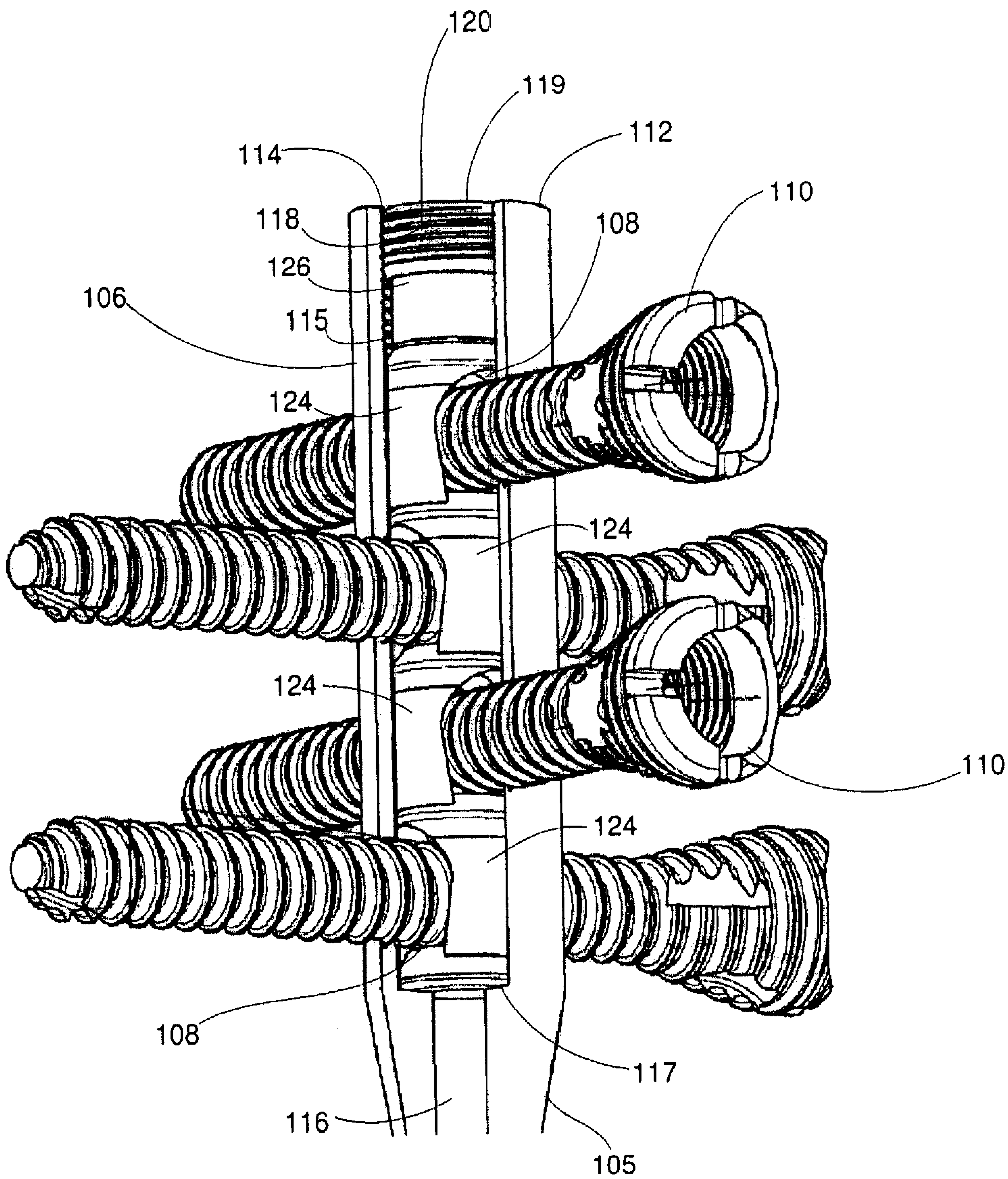

120
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FIG. 2

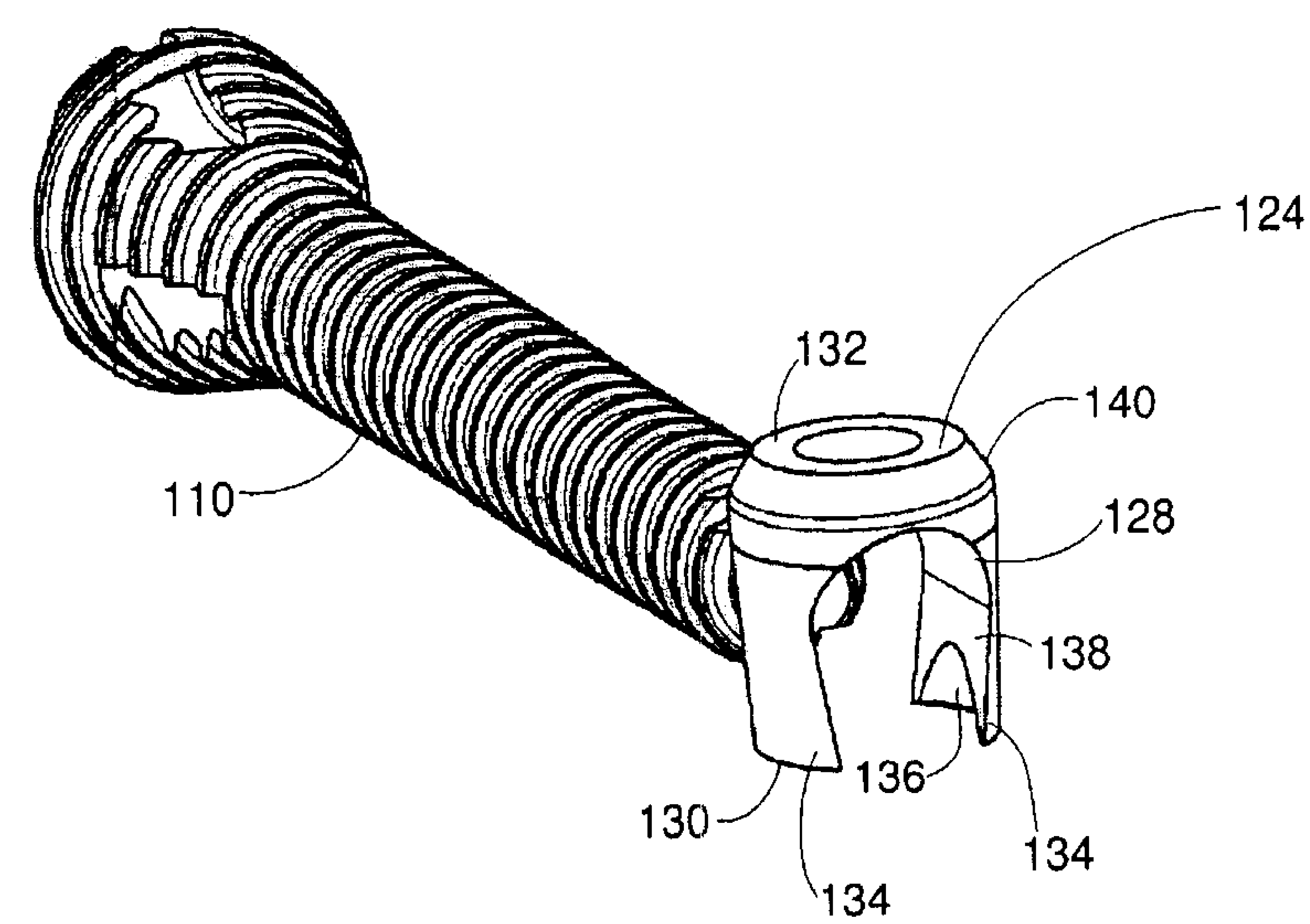


FIG. 3

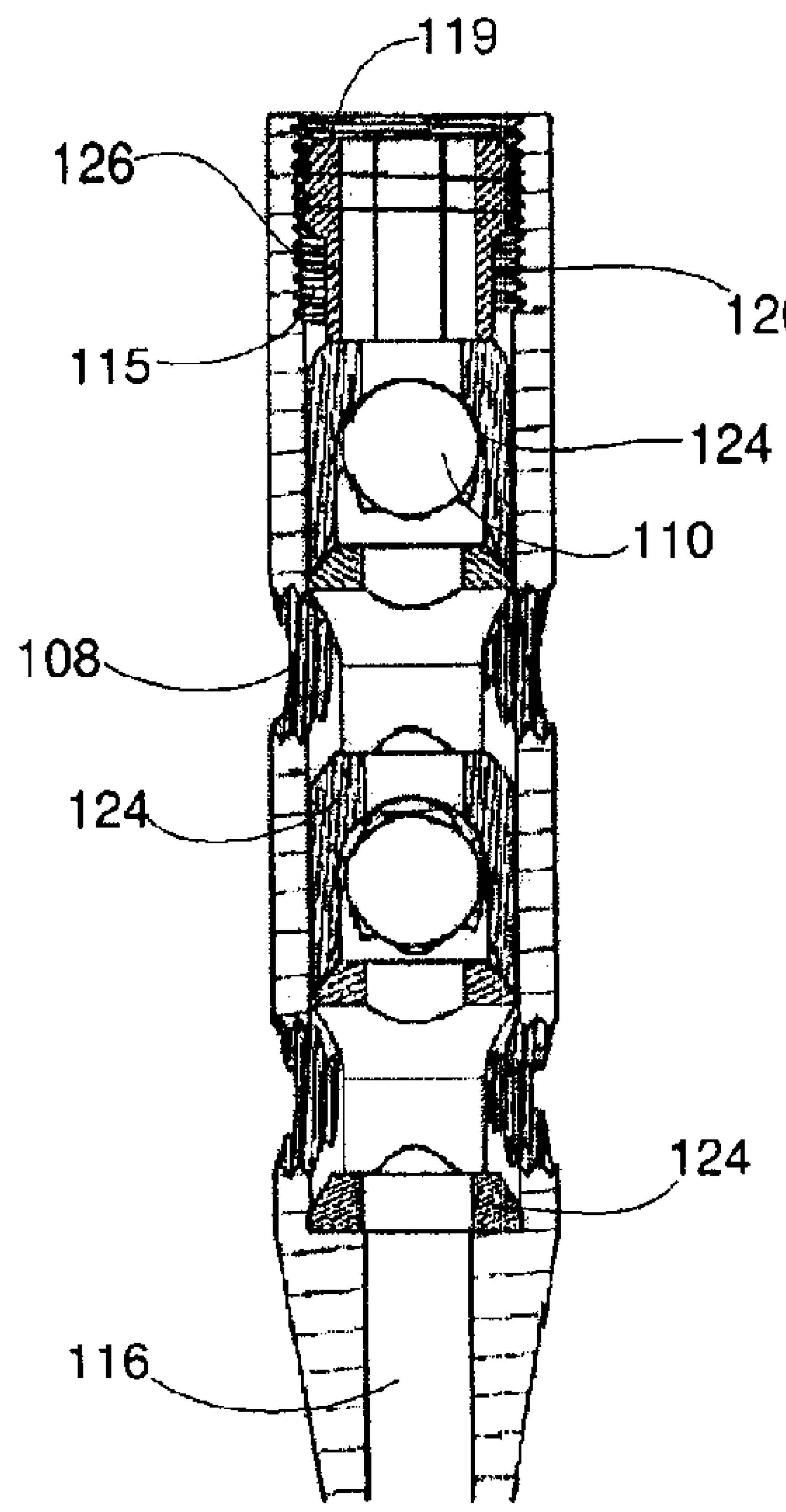


FIG. 4

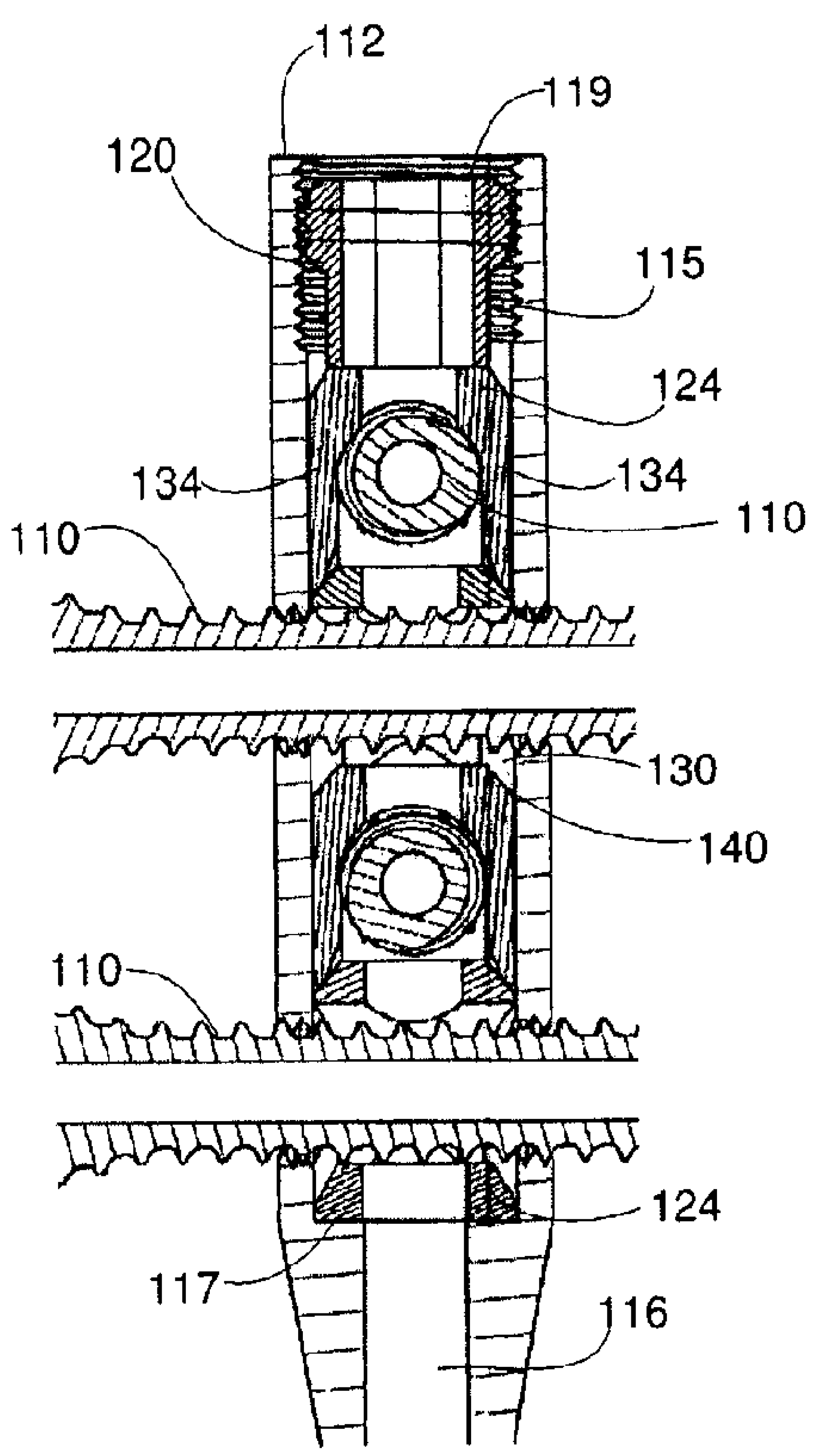


FIG. 5

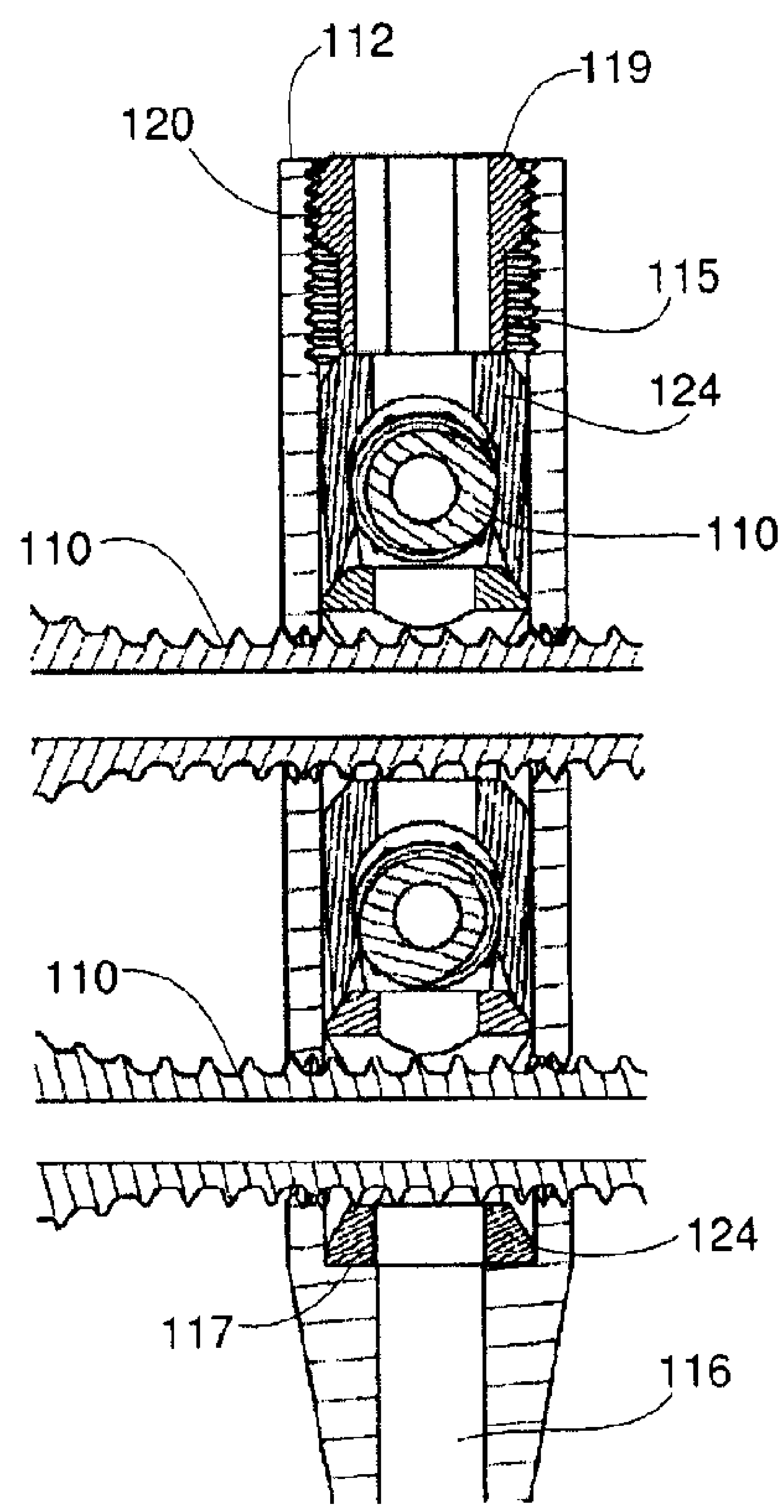


FIG. 6

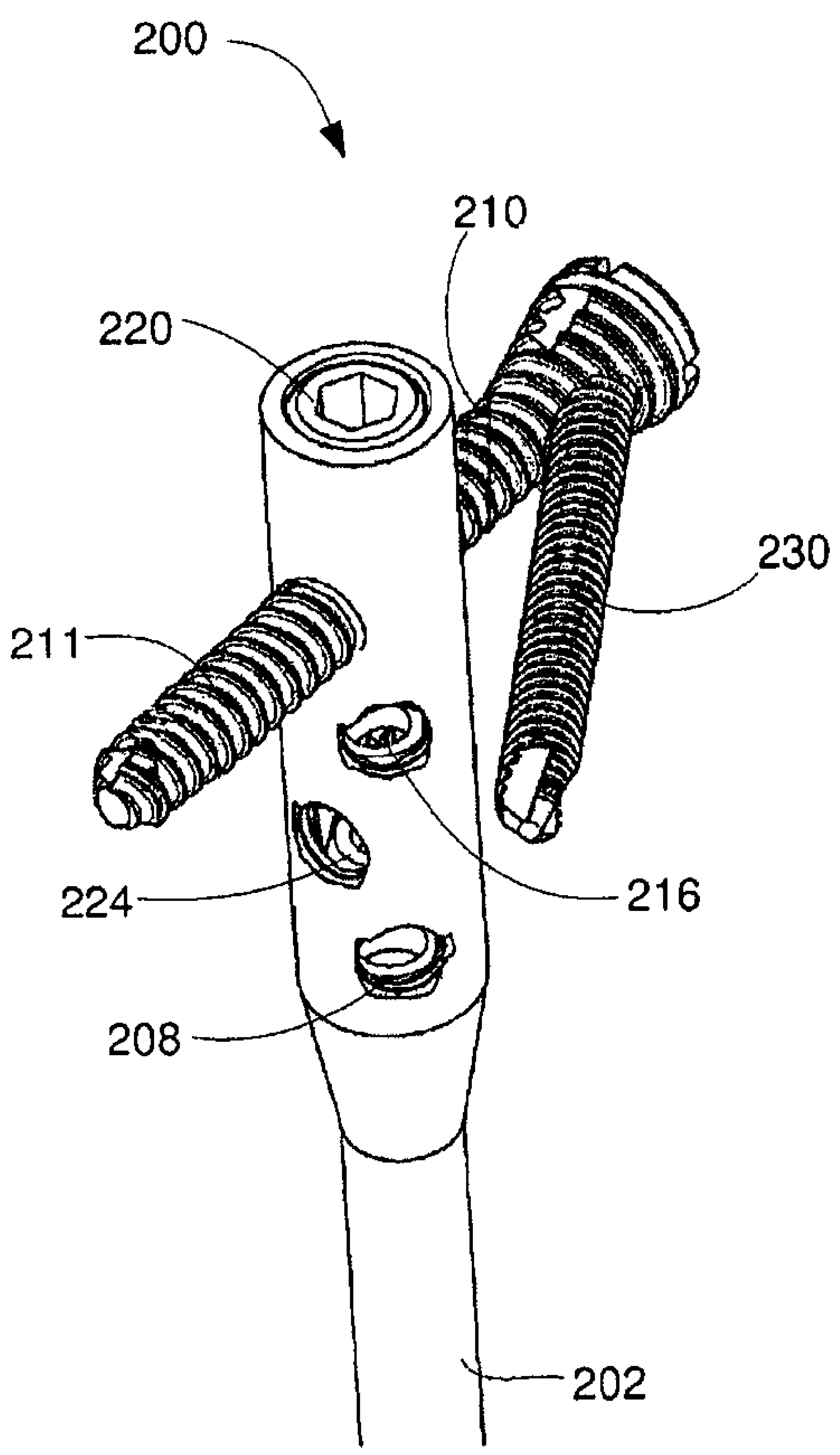


FIG. 7

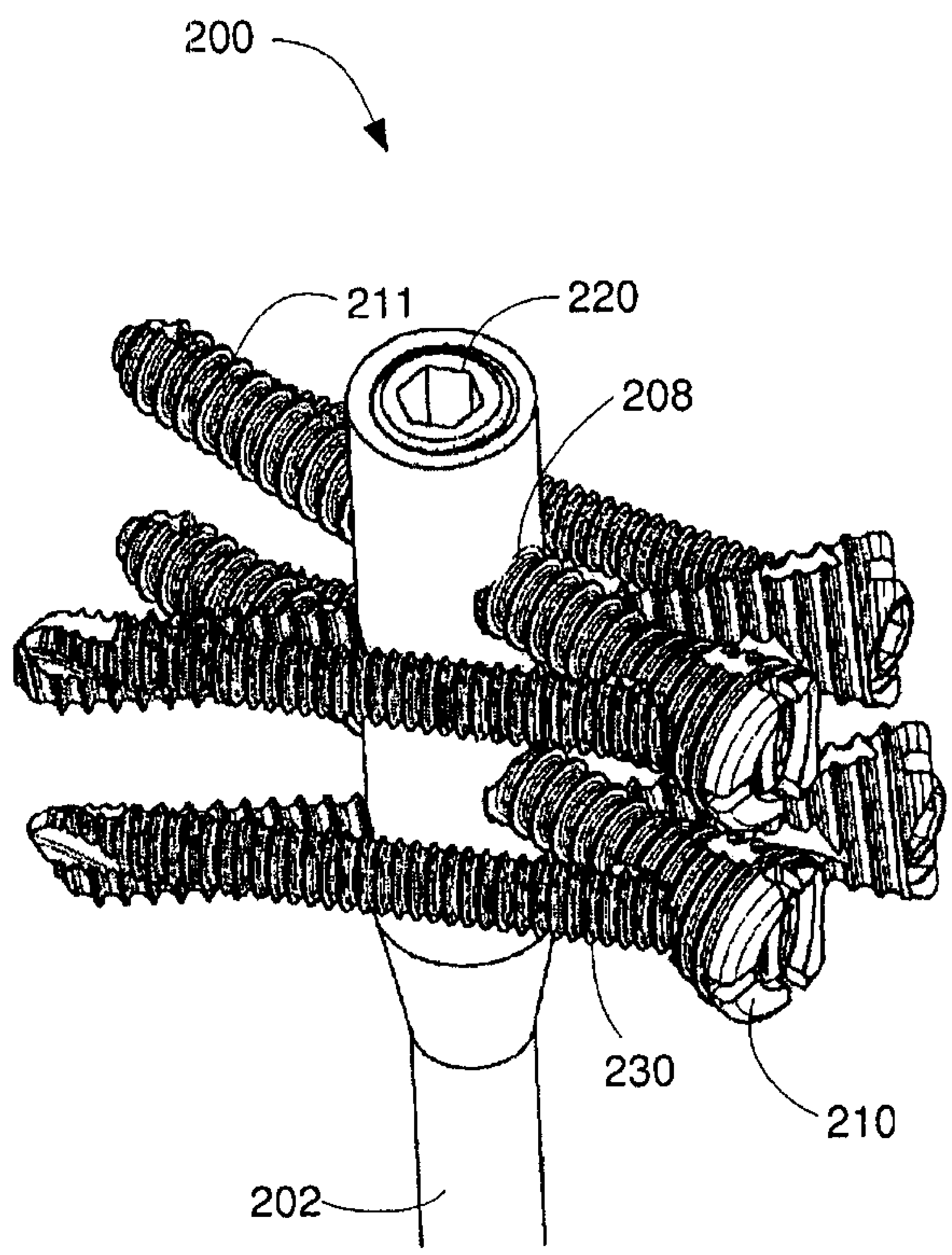


FIG. 8

FIG. 9

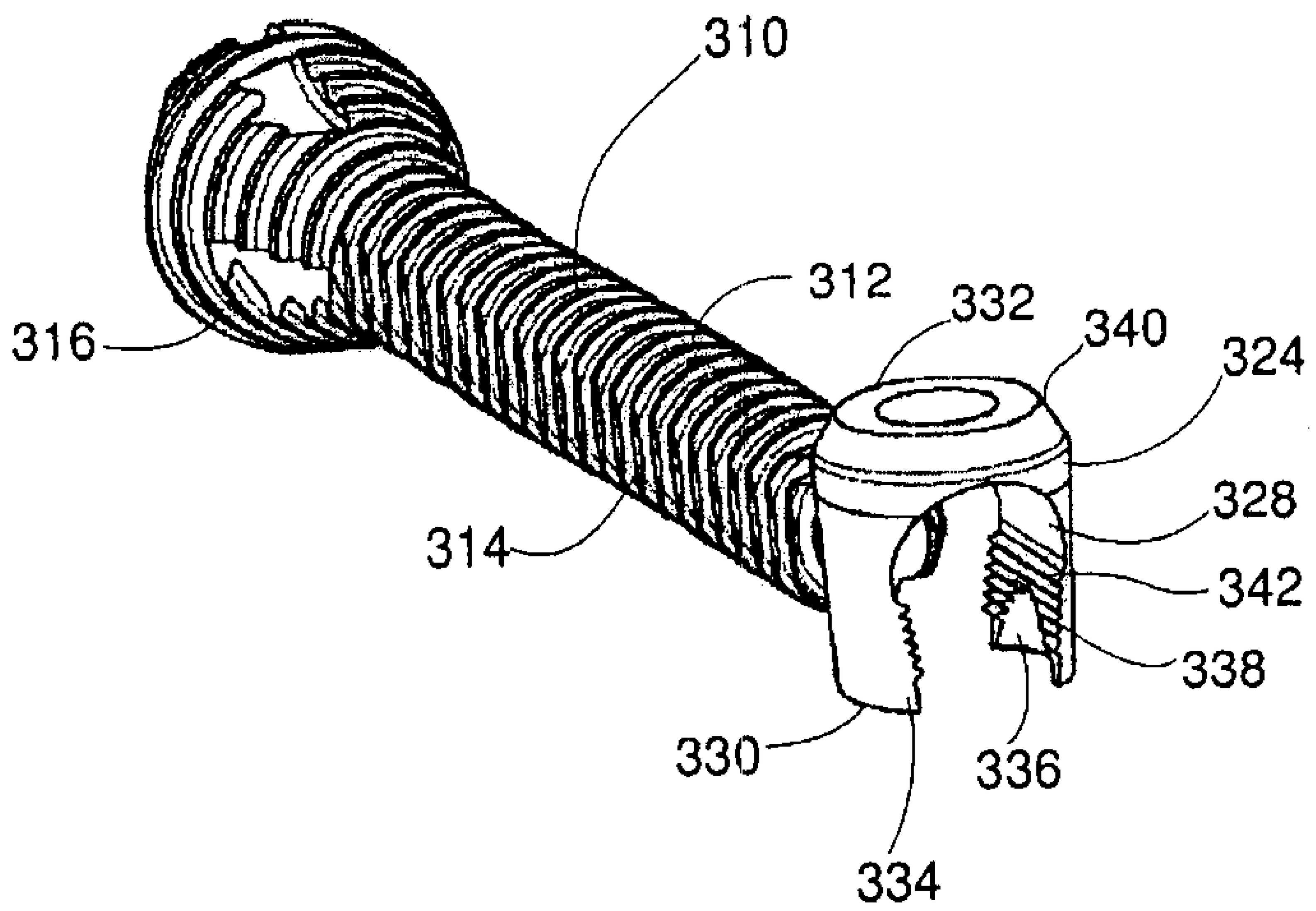


FIG. 10

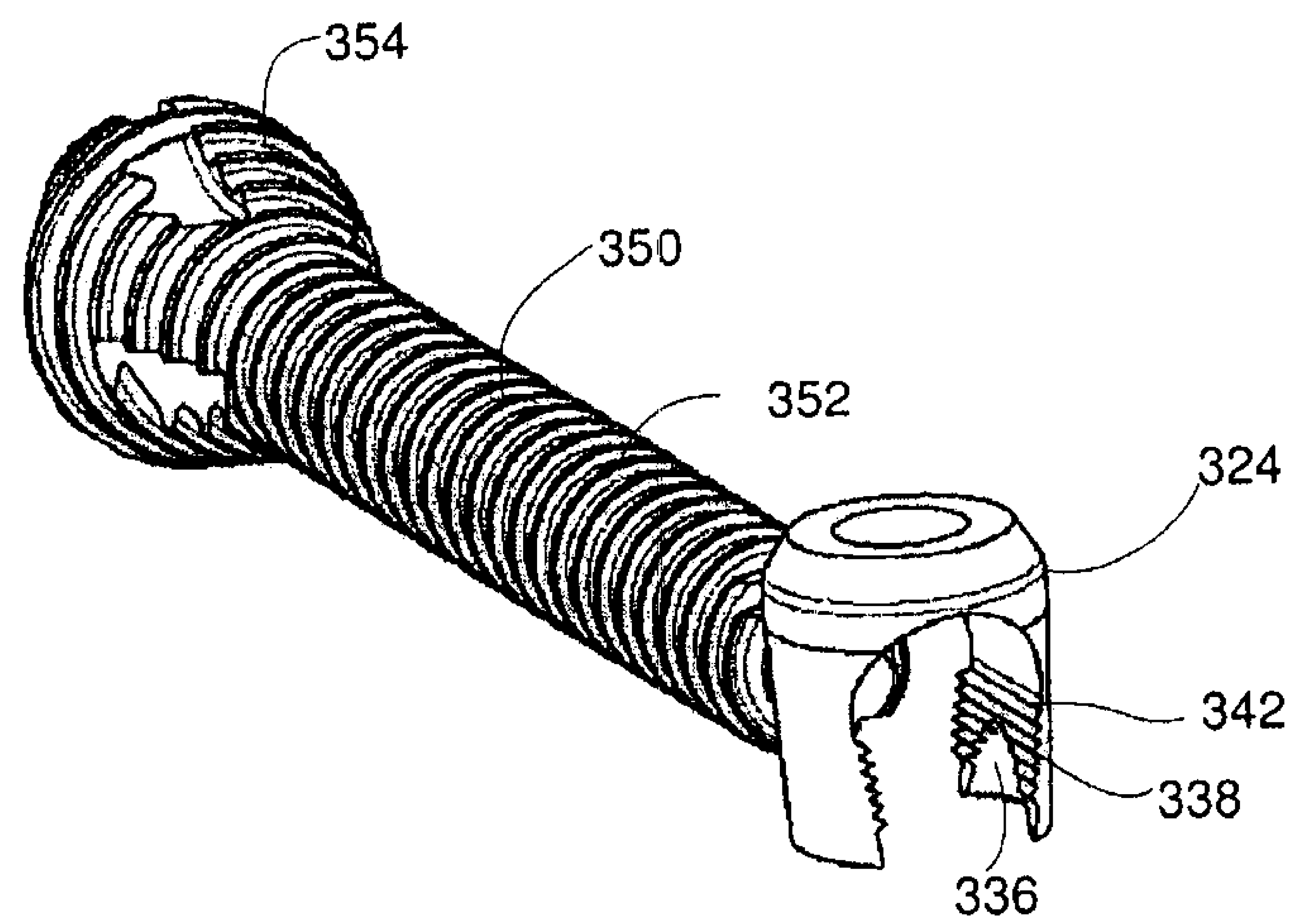


FIG. 11

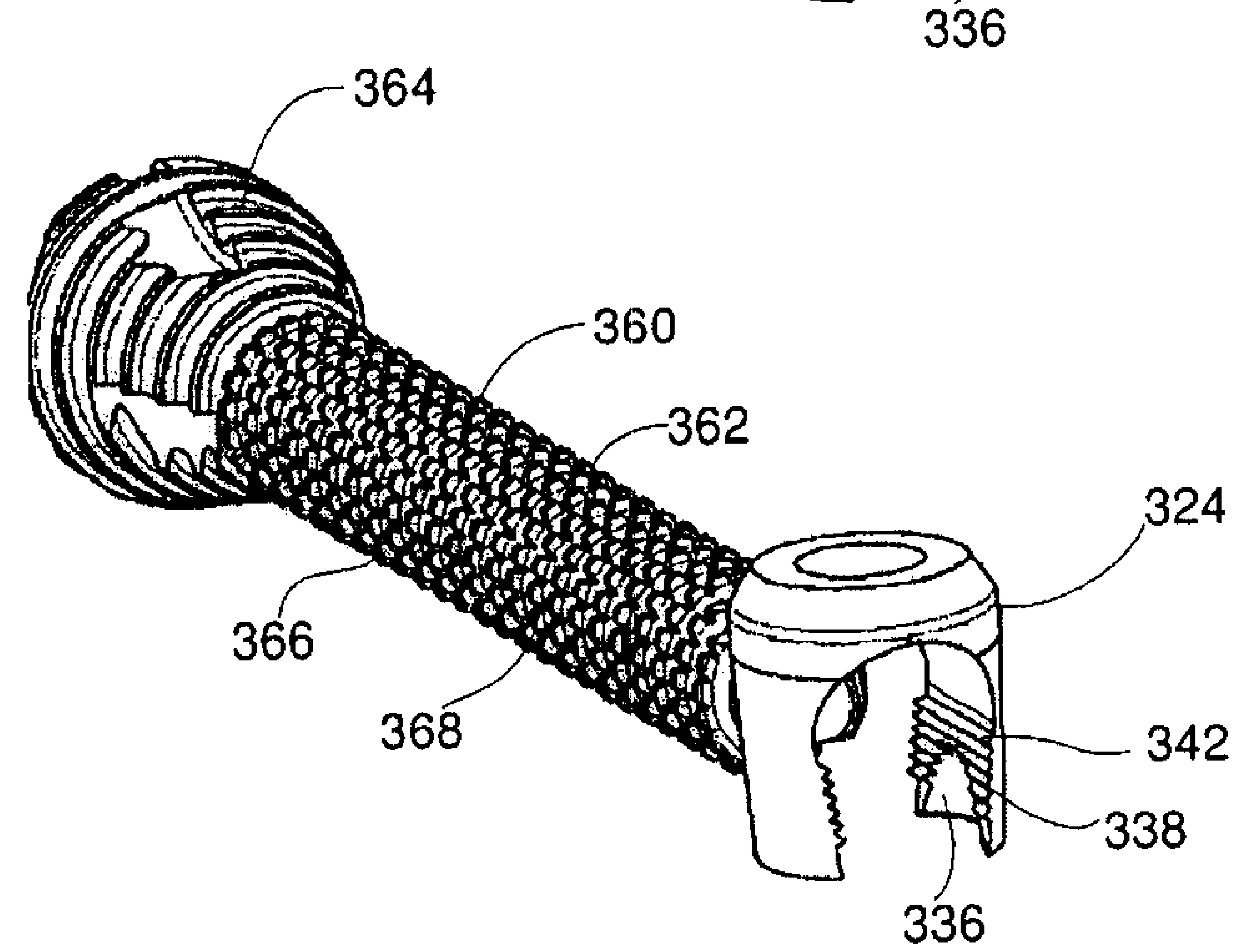


FIG. 12

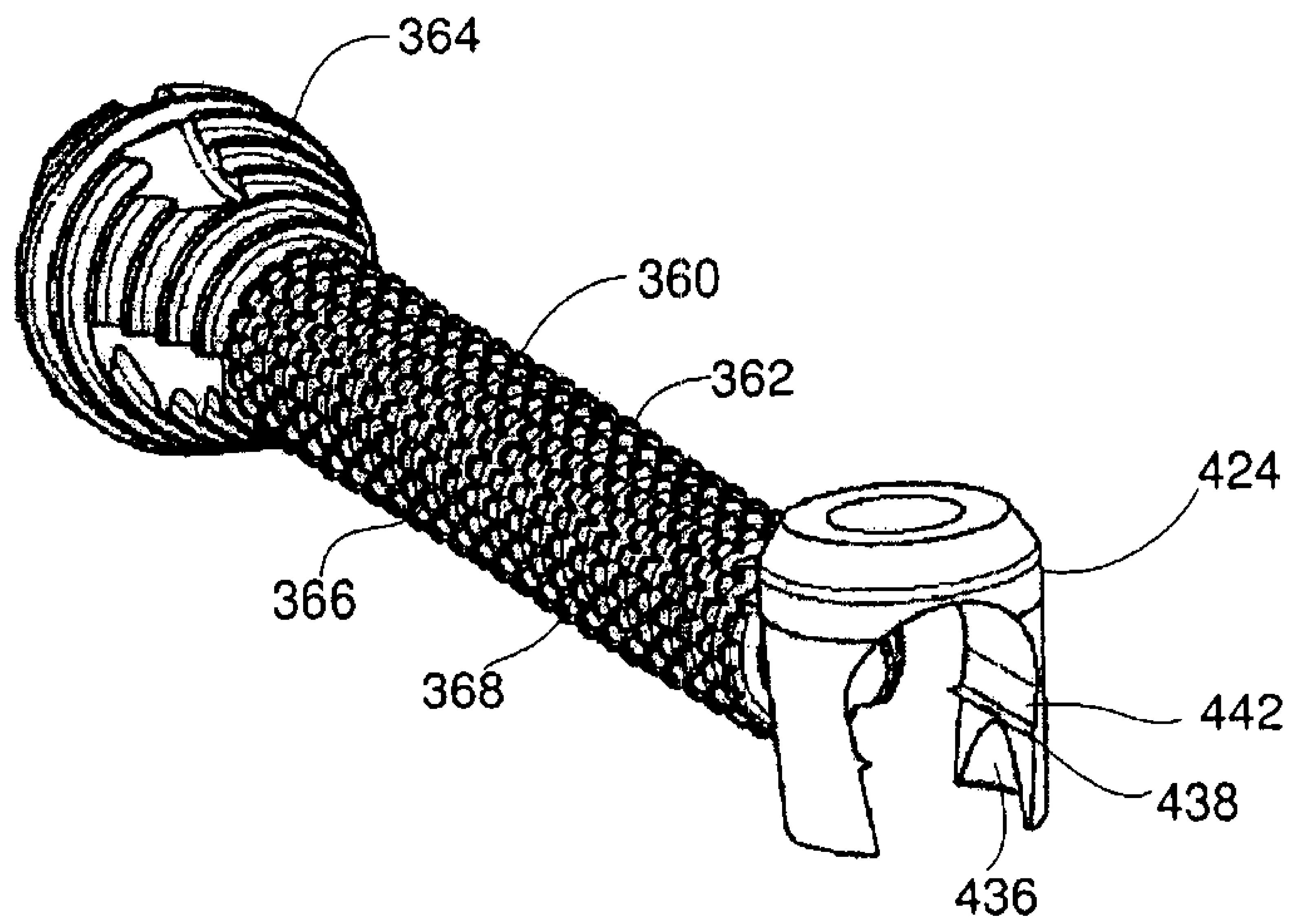


FIG. 13

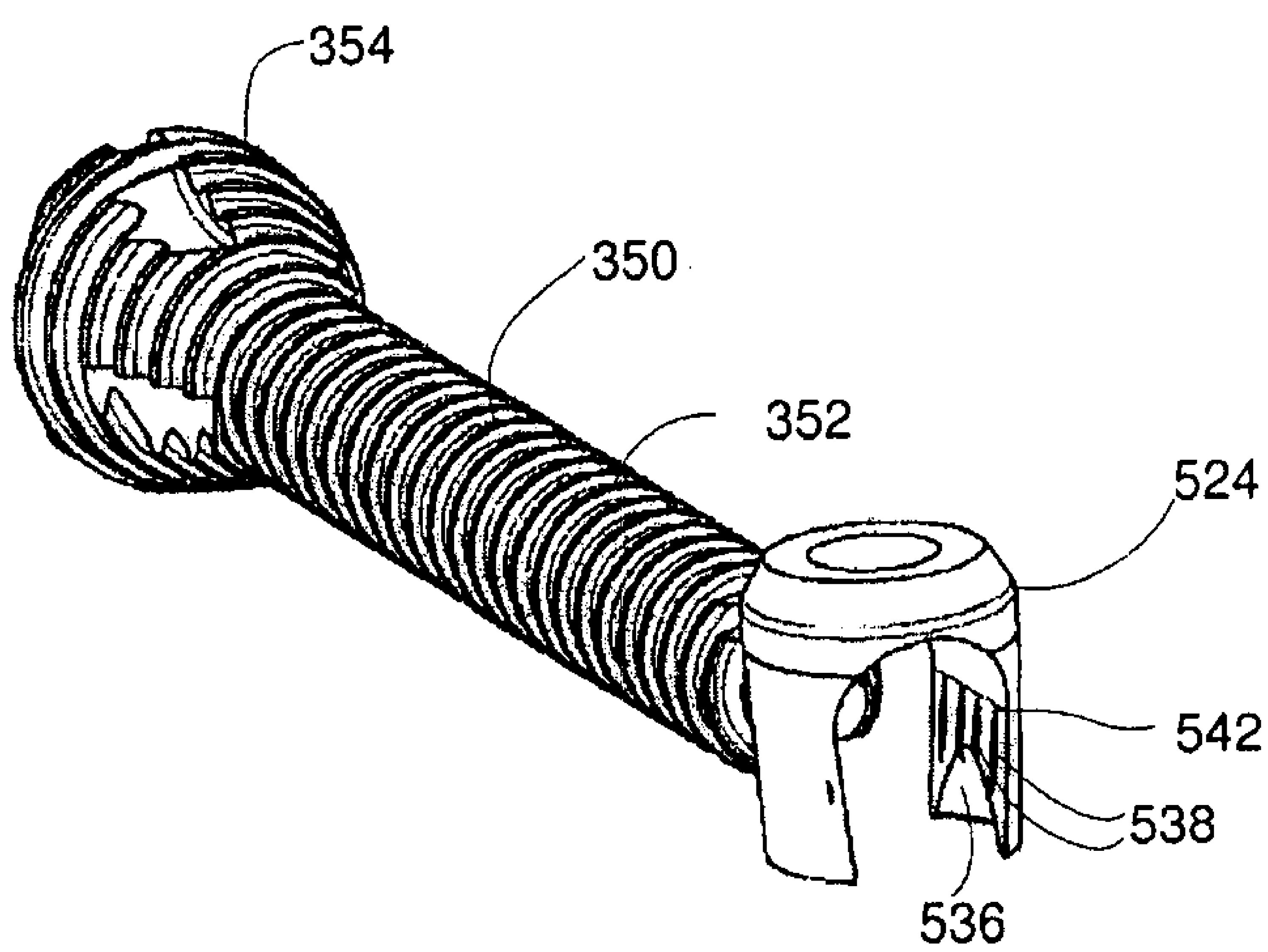
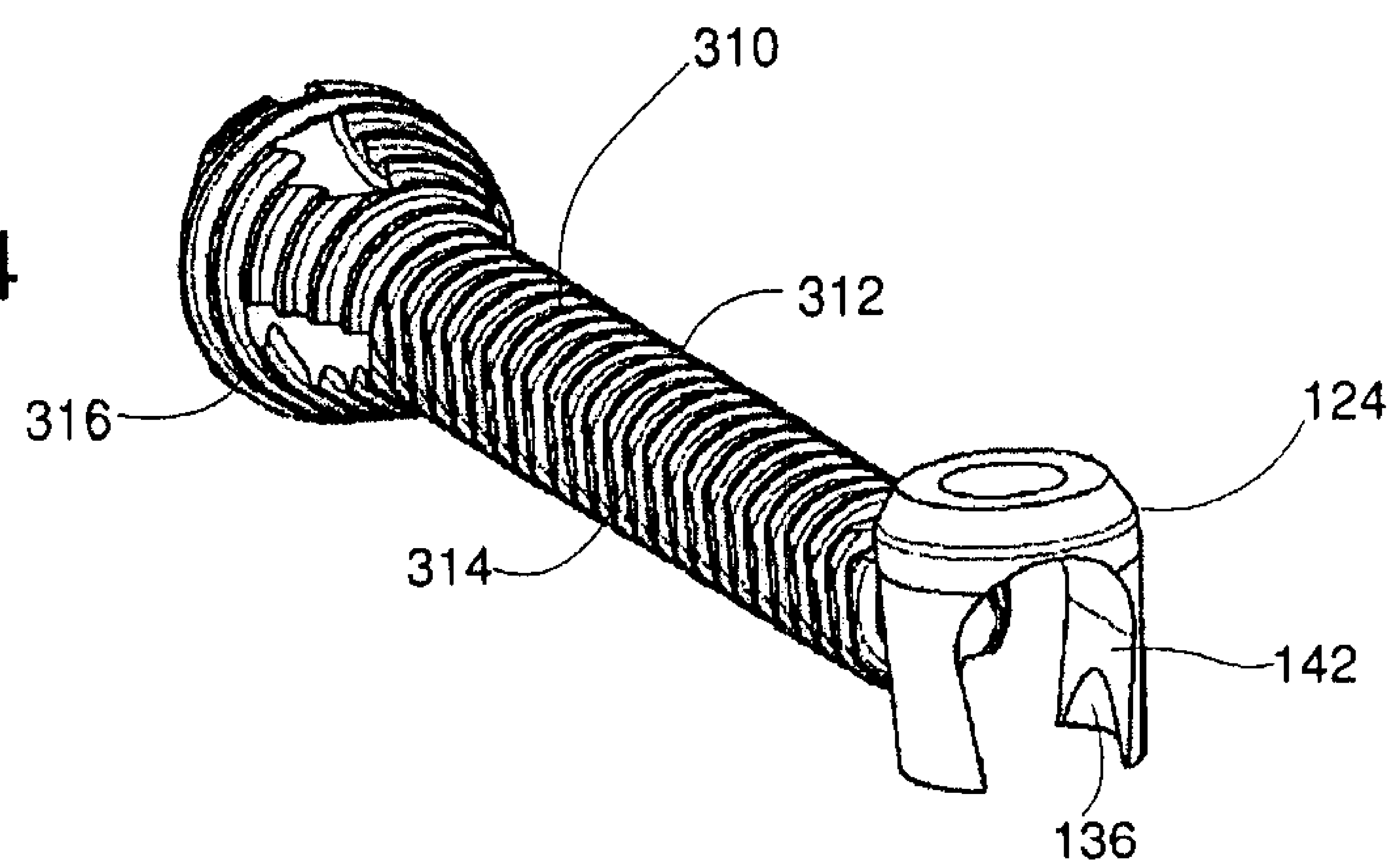


FIG. 14



INTRAMEDULLARY NAIL AND PROTRUDING SCREW LOCKING MECHANISM

PRIORITY CLAIM

The present application claims priority to U.S. Provisional Application Ser. No. 61/222,234 entitled "Intramedullary Nail and Protruding Screw Locking Mechanism" filed on Jul. 1, 2009 to Tom Overes, Silas Zurschmiede, Simone Volzer and Robert Frigg, the entire disclosure of which is incorporated herein by reference.

FIELD OF THE INVENTION

The present application is directed to the field of bone fixation and, more specifically, to a system and method for the fixation of bone fractures via an insertion of an intramedullary nail into the bone, the intramedullary nail being configured to receive bone screw therethrough in an operative configuration.

BACKGROUND INFORMATION

Intramedullary nails are used to stabilize and align fractured or otherwise damaged bones. Known procedures often employ bone screws inserted through the bone to engage an intramedullary nail at various angles relative to one another to stabilize the nail in the bone or to aid in stabilizing individual bone fragments. These bone screws are locked in place within the intramedullary nail via forced tapping into plastic or metal bushings. This may result in a loosening of the grip on the screws (e.g., when a screw is unthreaded from a previously tapped threading) and/or the creation of debris as the screws are tapped into the material of the bushing.

SUMMARY OF THE INVENTION

The present invention is directed to an apparatus for treating a bone, comprising an implant to be received within an interior of a bone, the implant including a plurality of cross bores extending therethrough and a cavity extending within the implant along at least a portion of a length thereof, each of the cross bores extending through the cavity and being dimensioned to receive therethrough a bone fixation element and a plurality of inserts slidably received in the cavity, each insert including an insert opening extending therethrough, the inserts being aligned within the cavity so that each insert opening aligns with a corresponding one of the cross bores, each insert being movable between a resting configuration in which a width of its insert opening is smaller than a width of a bone fixation element to be inserted through the corresponding cross bore and a stressed configuration in which the width of the insert opening is expanded to a width greater than that of the bone fixation element to be inserted through the corresponding cross bore in combination with a compression member movable into the cavity to apply a force to the inserts moving the inserts from the resting configuration to the stressed configuration, withdrawal of the compression member to reduce the force applied to the inserts permitting the inserts to return to resting configuration.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a perspective view of an intramedullary nail according to a first embodiment of the invention;

FIG. **2** shows a first partial cross-sectional view of the intramedullary nail of FIG. **1**;

FIG. **3** shows a perspective view of an exemplary insert of FIG. **1**;

FIG. **4** shows a second partial cross-sectional view of the intramedullary nail of FIG. **1**;

FIG. **5** shows a third partial cross-sectional view of the intramedullary nail of FIG. **1**;

FIG. **6** shows a fourth partial cross-sectional view of the intramedullary nail of FIG. **1**;

FIG. **7** shows a first perspective view of an intramedullary nail according to a second exemplary embodiment of the present invention;

FIG. **8** shows a second perspective view of the intramedullary nail of FIG. **7**;

FIG. **9** shows an insert and bone screw according to a third alternate embodiment of the present invention;

FIG. **10** shows an insert and bone screw according to a fourth alternate embodiment of the present invention;

FIG. **11** shows an insert and bone screw according to a fifth alternate embodiment of the present invention;

FIG. **12** shows an insert and bone screw according to a sixth alternate embodiment of the present invention;

FIG. **13** shows an insert and bone screw according to a seventh alternate embodiment of the present invention; and

FIG. **14** shows an insert and bone screw according to an eighth alternate embodiment of the present invention.

DETAILED DESCRIPTION

The present invention may be further understood with reference to the following description and the appended drawings, wherein like elements are referred to with the same reference numerals. The present invention relates generally to systems and methods for the fixation of fractured or otherwise damaged bone. Specifically, the invention relates to an intramedullary nail formed with a hollow cavity configured to receive at least one substantially cylindrical insert therein. The insert comprises an opening extending therethrough and configured to at least partially align with a bore extending perpendicularly through the intramedullary nail. Although, in a resting state, a width of the insert opening is smaller than a diameter of the bore, when the insert is compressed axially, a width of the insert opening expands to a size sufficient to permit a bone locking screw to be freely inserted therethrough. Thus, the exemplary intramedullary nail of the present invention permits a user to loosely insert at least one bone screw through at least an insert of the hollow cavity. After the bone screw has reached a desired position within the bone, the axial compression is withdrawn from the insert and the insert opening retracts to its resting state applying a radially constrictive pressure to the bone screw, thus locking a position thereof relative to the intramedullary nail and minimizing the problems associated with screws tapping into bushings described above.

As shown in FIGS. **1**-**2**, a system **100** according to an exemplary embodiment of the invention comprises an intramedullary nail **102** having an elongated shaft **104** extending from an increased diameter head **106** at a proximal end **112** and connected thereto by a tapered portion **105**. As would be understood by those skilled in the art, dimensions of the elongated shaft **104** and the head **106** may be selected to conform to the requirements of a target bone fixation procedure. In an exemplary embodiment, an insert **124** is formed of Cobalt Chromium. Alternatively, the insert **124** may be formed of any material exhibiting a residual elasticity, as those skilled in the art will understand. A cavity **114** extends longitudinally into the head **106** from the proximal end **112** to a seat **117** at a distal end thereof. A plurality of cross bores **108** extend through the head **106** and the cavity **114**. In this embodiment, an axis of each of the cross bores **108** is substantially perpendicular to a longitudinal axis of the intramedullary nail **102**. The axes of the cross bores **108** may be distributed about the longitudinal axis of the intramedullary nail in any desired pattern. That is, the cross bores **108** may be distributed about the circumference of the head **106** in any desired pattern so long as they intersect the cavity **114**. Each of the cross bores **108** is positioned at a location selected to receive a bone fixation element (e.g., a bone screw **110**) to be mounted through the intramedullary nail **102**. As shown in the partial cross-sectional view of FIG. **4**, each of the bores **108** may comprise female threading with a pitch corresponding to a male threading of the bone screws **110**. It is noted that although the embodiment of FIGS. **1-2** is shown with four bone screws **110** inserted through four substantially perpendicularly positioned cross bores **108**, the cross bores **108** of the present invention may be positioned at any angles relative to one another without deviating from the spirit and scope of the present invention. Furthermore, the intramedullary nail **102** of the present invention may be provided with any number of bores **108** without deviating from the scope of the present invention. A reduced diameter cavity **116** may extend distally from the cavity **114** if desired to permit insertion of a Kirschner wire ("K-wire") through the intramedullary nail **102**. Specifically, a K-wire (not shown) may be pre-implanted in a target portion of the bone prior to insertion of the intramedullary nail **102**. The intramedullary nail **102** may be inserted into the bone so that the K-wire slides in from a distal opening of the reduced diameter cavity **116** adjacent the distal end of the shaft **104**. Each of the inserts **124** may also comprise bores (not shown) extending therethrough, the bores being configured to permit slidable movement of the K-wire therepast. As those skilled in the art will understand, the K-wires may be removed from the intramedullary nail **102** prior to the insertion of bone screws **110** through the cross bores **108**. In an exemplary embodiment of the present invention, the intramedullary nail **102** and the bone screws **110** are formed of titanium or a titanium alloy, although other materials may be employed without deviating from the scope of the present invention.

As shown more clearly in the partial cross-sectional view of FIG. **2**, the cavity **114** extends substantially parallel to a longitudinal axis of the intramedullary nail **102** and is open to each of the bores **108**. A portion of the cavity **114** adjacent to the proximal end **112** is formed with female threading **115** with a predetermined pitch corresponding to a male threaded portion **118** of a bolt **120** to be inserted therein. As shown in FIG. **2**, the female threading **115** extends into the cavity **114** by a predetermined distance. The bolt **120** may further comprise a driver connection **122** configured to engage a driving instrument to permit the insertion thereof into the cavity **114**, as those skilled in the art will understand. The driver connection **122** may be a hexagonal socket, a torx drive, or any other suitable drive. The bolt **120** which further comprises a non-threaded shaft portion **126** configured to be slidably received in the cavity **114** to abut a proximal-most one of a plurality of inserts **124** slidably received in the cavity **114** may also be formed of one of titanium, a titanium alloy, cobalt chromium or any other suitable material.

Each insert **124** is biased toward a resting shape substantially conforming to a shape of the cavity **114** with a clearance between a radially outer surface of the insert **124** and an inner wall of the cavity **114** to permit expansion of the insert **124** as will be described in more detail below. If desired, the shape of each of the inserts **124** may be selected so that they may be received in the cavity **114** only in an orientation with respect to the longitudinal axis of the intramedullary nail **102** in which the opening **128** thereof will align with a corresponding cross bore **108**. Each insert **124** includes a proximal abutting surface **132** and distal abutting surfaces **130** which engage adjacent ones of the inserts **124** except that the proximal abutting surface **132** of the proximal-most one of the inserts **124** abuts the distal end of the bolt **120** and the distal surfaces **130** of the distal-most one of the inserts **124** abuts the seat **117** of the cavity **114**. Each insert **124** includes a pair of arms **134** separated from one another by an arced opening **128** extending from a distal end of the insert **124** to a distal face of the proximal abutting surface. Dimensions of the opening **128** are selected to be smaller than a diameter of a bone screw **110** to be inserted therethrough so that, when the insert **124** is in a first unstressed configuration, the bone screw **110** is prevented from being inserted therethrough. Each of the arms **134** includes a cutout **136** on a radially inner wall thereof adjacent the distal abutting surface **130** thereof for receiving the proximal end of an adjacent insert **124** as will be described in more detail below. Furthermore, a width of the opening **128** decreases as the distal abutting surfaces **130** are approached, aiding in longitudinal compression of the insert **124**, as will be described in greater detail hereinafter. A chamfer **140** is formed between the proximal ends of the arms **134** and the proximal abutting surface **132** which has a diameter smaller than that of the arms **134**. The arms **134** extend distally at a substantially constant diameter so that the distal abutting surfaces **130** of one insert **124** contact the chamfer **140** of the distally adjacent insert **124**. The cutouts **136** provide clearance for the radially outer end of the proximal abutting surface **132** of the adjacent insert **124** so that the arms **134** contact the angled chamfer at the angled surface formed by the cutouts **136** when the inserts **124** are stacked atop one another in the cavity **114** with the distal abutting surfaces **134** of one insert **124** resting on the proximal abutting surface **132** of an adjacent insert **124**. A taper angle of the chamfer **140** is selected to provide a desired degree of radial expansion of the opening **128** as the arms **134** move distally over the chamfer **140** and are spread radially apart from one another. Specifically, when the bolt **120** is turned to force the bolt **120** further distally into the cavity **114**, the proximal-most insert **124** is compressed axially against the adjacent insert **124** sliding the arms **134** thereof distally over the chamfer **140** of the adjacent insert **124** and expanding the opening **128** to a size selected to facilitate the free insertion of a bone screw **110** thereinto. This axial force is transmitted from each insert **124** to the distally adjacent insert **124** expanding all of the openings **128** to the desired size. The bone screws **110** may then be inserted as would be understood by those skilled in the art. A steeper angle of the chamfer **140** is directly related to an increased pivotal distance that the chamfer **140** must travel before expanding the opening **128** to the desired size. Furthermore, the combination of a low pitch of the threaded portion **118** of the bolt **120** and a steep angle of the chamfer **140** results in an axial force multiplication, wherein the threads and the chamfer **140** proportionally increase a magnitude of the axially applied force, as those skilled in the art will understand. The increased magnitude of the axially applied force permits the use of a substantially stiff material for the inserts **124**, so that the material will be sufficiently rigid to withstand forces applied thereto during and after insertion into a target portion of bone while permitting the temporary deformation required to facilitate insertion of the bone screws **110**.

In accordance with an exemplary method of use of the system **100**, a plurality of inserts **124** are inserted into the cavity **114** with an axis of each of the openings **128** aligned with an axis of a corresponding one of the cross bores **108**. The bolt **120** is then screwed into the cavity **114** until a top surface thereof extends into the cavity **114** by a predetermined distance, as shown in the partial cross-sectional view of FIGS. **4** and **5**. As described above, the driving of the bolt **120** distally into the cavity **114** exerts an axial force on a first one of the inserts **124** located adjacent thereto which force is transmitted to the rest of the inserts **124** in turn. Those skilled in the art will understand that, the steps for the expansion of the openings **128** may be performed before or after the intramedullary nail **102** has been inserted into the body using any known technique. Furthermore, in an alternate embodiment, the movement of the bolt **120** into the cavity **114** may be offset from the longitudinal axis of the intramedullary nail **102** so long as the force applied thereby against the first insert **124** is translated into an axially compressive force (e.g., through the movement of the bolt **120** laterally against the chamfer **140** to redirect the force distally. Specifically, the bolt **120** may be inserted over the first one of the inserts at an angle deflected from a longitudinal axis of the cavity **114** by up to 90°. It is further noted that the pitch of the threaded portion **118** of the bolt **120** may be selected to conform to the amount of axial displacement desired, wherein a lower pitch corresponds to a increased axial force applied to the inserts **124** for a certain rotational movement, as those skilled in the art will understand. The axial force applied to the first adjacent insert **124** then causes the same axial compression and radial expansion of the arms **134** described above.

As shown in FIG. **5**, the radial expansion of the insert **124** causes each of the openings **128** to assume dimensions large enough to permit insertion of shafts **111** of the bone screws **110** therethrough with a minimal amount of friction therebetween while still preventing heads **113** of the bone screws **110** from being inserted thereinto. The bone screws **110** may then be inserted into the cross bores **108** using any known technique. Once each of the bone screws **110** has been inserted to a target location within the cross bores **108** and inserts **124**, the bolt **120** is rotated (e.g., counter-clockwise) to move the bolt **120** proximally out of the cavity **114** gradually reducing the axially compressive forces applied to the inserts **124**. In a preferred embodiment, the bolt **120** is retracted to a position wherein a first end **119** of the bolt **120** lies substantially flush against the proximal end **112** of the intramedullary nail **102**. Reduction of the axially compressive force applied to the inserts **124** permits the inserts **124** to return to their initial non-stressed configurations with the arms **134** moving radially inward against the bone screws **110** gripping the bone screws **110** and locking them in place. The inserts **124** are preferably formed of a material which, when compressed to receive a bone screw **110**, is elastically deformed so that the process may be repeated (e.g., if it is necessary to withdraw and reinsert bone screws **110** for any reason) without compromising the efficacy of the inserts **124**. Because each of the bone screws **110** of the present invention is locked independent of other bone screws, a user may optionally use only a number of bone screws **110** called for in a particular procedure. That is, a user of not required to employ as many bone screws **110** as there are cross bores **108**. For example, in the embodiment of FIGS. **1-6**, a user may optionally use less than four bone screws **110** without compromising the strength of the frictional engagement on each of the bone screws **110**.

As shown in FIGS. **7** and **8**, a system **200** according to another embodiment of the invention is formed substantially similarly as the system **100** except that an angle of each of a plurality of cross bores **208** with respect to a longitudinal axis of an intramedullary nail **202** is varied. Furthermore, first bone screws **210** of the system **200** are configured to permit screw-in-screw insertion, as those skilled in the art will understand. The exemplary system **200** may be employed, for example, in the proximal humerus where the employment of first bone screws **210** at a plurality of angles finds particular benefit. The cross bores **208** may be threaded with a female threading corresponding to a male threading of shafts **211** of each of the bone screws **210**. Furthermore, inserts **224** of the system **200** are configured with openings (not shown) that extend therethrough at angles corresponding to the angles of the respective ones of the cross bores **208** so that, when the inserts **224** are stacked within a cavity **216** of an intramedullary nail **202**, axes of the openings (not shown) align with axes of the respective ones of the cross bores **208**. The first bone screws **210** may each comprise a bore **212** configured to receive a respective second bone screw **230** therethrough. Specifically, whereas the first bone screws **210** are configured to be inserted and locked within a respective cross bore **208** of the intramedullary nail **202**, the second bone screws **230** are configured to engage the first bone screws **210** at any appropriate angle to provide an additional locking strength to the system **200**.

Various modifications may be made to the inserts and bone screws of the present invention including, but not limited to the embodiments shown in FIGS. **9-14**. Specifically, FIG. **9** depicts an insert **324** engageable with a bone screw **310**. The insert **324** is formed substantially similarly to the insert **124** of FIGS. **1-6**, comprising a substantially cylindrical body with an opening **328** extending therethrough to define first and second arms **334**. A cutout **336** located on an inner wall of the insert **324** is located adjacent to and open to a distal end **330** while a taper **340** extends to a proximal end **332**. The insert **324** differs from the insert **124** in that a frictionally contacting surface **338** thereof is provided with multiple teeth **342** that extend into the opening **328** at a predetermined taper angle. The teeth **342** only extend along a predetermined portion of the contacting surface **338** configured to engage a shaft **312** of the bone screw **310** in an operative configuration. The shaft of the bone screw **310** is provided with two opposing flattened walls **314** configured to engage the teeth **342**. Specifically, once the bone screw **310** has been inserted through the radially expanded insert **324**, as described in greater detail with respect to FIGS. **1-6**, release of the axially compressive force on the inserts **324** allows the aims **334** to retract radially inward over the outer wall of the shaft **312**. The teeth **342** then apply a radially constrictive pressure against the flattened walls **314** locking a position of the screw **310** with respect to the intramedullary nail (not shown). Those skilled in the art will understand that engagement of the teeth **342** with the threads of the shaft **312** increases a frictional locking force between the insert **324** and the bone screw **310**. It is further noted that although teeth **342** are described in the present embodiments, the insert **324** may optionally be provided with any type of a roughened or treated surface to increase friction without deviating from the scope of the present invention.

The bone screw **310** may also be employed in place of the bone screw **210** of FIGS. **7-8**, wherein the flattened walls **314** will ensure that the bone screw **310** is inserted into the insert **224** in a predetermined orientation with the flattened walls **314** engaging the contacting surfaces of the inner walls of the insert **224**. In this manner, a surgeon or other user can ensure that the second bone screw **230** assumes a predetermined position when inserted into the bone screw **310** and also prevent screw collisions, as those skilled in the art will understand.

In another embodiment of the present invention, as shown in FIG. **10**, the insert **324** is configured to engage a standard bone screw **350** comprising a shaft **352** extending from an increased diameter head **354**, wherein the shaft **352** comprises a substantially circular cross-section. Engagement of the teeth **342** of the insert **324** with the threads of the shaft **352** is facilitated in the same manner discussed above. In yet another embodiment, as shown in FIG. **11**, the insert **324** may be configured to engage a bone screw **360** having a shaft **362** and an increased diameter head **364**. The shaft **362** comprises threads **366** extending substantially helically around the shaft **352**, as those skilled in the art will understand. The shaft **362** is further provided with a plurality of transverse cuts **368** extending substantially parallel to a longitudinal axis of the bone screw **360**, the transverse cuts **368** defining a plurality of engagement portions to facilitate engagement with the teeth **342** of the insert **324**. Specifically, dimensions of a space between adjacent ones of the transverse cuts **368** is selected such that the teeth **342** can be received within each of the transverse cuts **368** to provide a form fit engagement in addition to a frictional engagement of the teeth **342** with the shaft **362**, as those skilled in the art will understand.

FIG. **12** depicts yet another embodiment of the present invention wherein an insert **424** is formed substantially similarly as the insert **324** of FIGS. **9-11** with the exception of the teeth **342**. Specifically, the insert **424** is provided with a single ridge **442** extending out of a frictionally contacting surface **438** thereof. The ridge **442** may extend substantially perpendicularly into the insert **424** or, in an alternate embodiment, may be angled relative thereto. The ridge **442** is configured to engage a transverse cut formed in the shaft **362** of the bone screw **360** by one of the transverse cuts **368**, as described in greater detail above.

FIG. **13** depicts yet another embodiment of the present invention, wherein an insert **524** is formed substantially similarly as the insert **124** of FIGS. **1-6** with the exception of a female threaded portion **542** formed on a contacting surface **538** of an inner wall of the insert **524**. The threaded portion **542** is formed with a predetermined pitch configured to engage threads of the threaded shaft **352**.

FIG. **14** depicts yet another embodiment of the present invention, wherein the insert **124** is configured to engage the bone screw **310** described in greater detail earlier with respect to FIG. **9**. Specifically, the insert **124** is operated in the same manner discussed above to engage the flattened wall **314** of the bone screw **310**.

In an alternate embodiment of the present invention, each of the elements of the present invention may be formed of any suitable material including, but not limited to a plastic, stainless steel or another biocompatible material. Furthermore, additional or lesser inserts **124** and respective cross bores **108** of the intramedullary nail **102** may be employed without deviating from the scope of the present invention. Still further, although embodiments of the present invention depict the use of multiple inserts formed with the same dimensions, the dimensions of each of the inserts and respective openings as well as the dimensions of each of the bone screws used in any particular procedure may be modified without deviating from the scope of the present invention. It is further noted that embodiments of the present invention may also be employed in any prosthesis with a shaft or elongating shaft such as, for example, hip prostheses and knee prostheses. Furthermore, embodiments of the present invention may be employed in tibial nails, femoral nails, humeral nails, etc. without deviating from the scope of the present invention. In another embodiment (not shown), the dimensions of the inserts may be modified to permit insertion in a hole extending through a bone plate instead of a nail

It will be apparent to those skilled in the art that various other modifications and variations may be made in the structure and the methodology of the present invention, without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover modifications and variations of the invention provided that they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. An apparatus for treating a bone, comprising:

an implant to be received within an interior of a bone, the implant including a plurality of cross bores extending therethrough and a cavity extending within the implant along at least a portion of a length thereof, each of the cross bores extending through the cavity and being dimensioned to receive therethrough a bone fixation element;

a plurality of inserts slidably received in the cavity, each insert including an insert opening extending therethrough, the inserts being aligned within the cavity so that each insert opening aligns with a corresponding one of the cross bores, each insert being movable radially between a resting configuration in which a width of its insert opening is smaller than a width of a bone fixation element to be inserted through the corresponding cross bore and a stressed configuration in which the width of the insert opening is expanded to a width greater than that of the bone fixation element to be inserted through the corresponding cross bore; and

a compression member movable into the cavity to apply a force to the inserts moving the inserts from the resting configuration to the stressed configuration, withdrawal of the compression member to reduce the force applied to the inserts permitting the inserts to return to resting configuration.

2. The apparatus of claim **1**, wherein the inserts are stacked on one another within the cavity and wherein the compression member comprises a bolt insertable into a proximal end of the cavity to apply a compressive force to a proximal-most one of the inserts, the compressive force being transmitted from one insert to another through the stack.

3. The apparatus of claim **1**, wherein an inner contacting surface of the opening of first one of the inserts includes a friction enhancing element to permit locking engagement with an outer surface of a bone fixation element to be inserted through the corresponding cross bore.

4. The apparatus of claim **3**, further comprising a cutout formed on the inner contacting surface to increase frictional engagement between the insert and a bone fixation element to be inserted through the corresponding cross bore.

5. The apparatus of claim **3**, wherein the friction enhancing element is one of a ridge, a cutout, a plurality of teeth and female threading.

6. The apparatus of claim **1**, wherein a proximal end of a first one of the inserts comprises a tapered surface angled with respect to a longitudinal axis of the implant and a distal end of a second one of the inserts proximally adjacent thereto includes a pair of arms separated from one another by the corresponding insert opening, distal ends of the arms of the second insert engaging the tapered surface of the first insert so that, when moved distally over the tapered surface of the first insert, the arms of the second insert are spread radially apart from one another increasing a width of the opening.

7. The apparatus of claim **1**, wherein each of the inserts includes a pair of distally extending arms separated from one another by the corresponding insert opening.

8. The apparatus of claim **6**, wherein the insert is formed of a material selected so that deformation thereof between the resting and stressed configurations is elastic.

9. The apparatus of claim **1**, wherein the insert is formed of Cobalt Chromium.

10. The apparatus of claim **1**, wherein the cross bore is threaded.

11. The apparatus of claim **1**, wherein each of the inserts is keyed to a shape of the cavity so that the inserts may be inserted thereinto only in an orientation in which the insert openings are aligned with the corresponding cross bores.

12. A system for treating a bone, comprising:

an implant to be received within an interior of a bone, the implant including a plurality of cross bores extending therethrough and a cavity extending within the implant along at least a portion of a length thereof, each of the cross bores extending through the cavity;

a plurality of bone fixation elements, each of the bone fixation elements being dimensioned for insertion through a corresponding one of the cross bores;

a plurality of inserts slidably received in the cavity, each insert including an insert opening extending therethrough, the inserts being aligned within the cavity so that each insert opening aligns with a corresponding one of the cross bores, each insert being movable radially between a resting configuration in which a width of its insert opening is smaller than a width of the bone fixation element to be inserted through the corresponding cross bore and a stressed configuration in which the width of the insert opening is expanded to a width greater than that of the bone fixation element to be inserted through the corresponding cross bore; and

a compression member movable into the cavity to apply a force to the inserts moving the inserts from the resting configuration to the stressed configuration, withdrawal of the compression member to reduce the force applied to the inserts permitting the inserts to return to resting configuration to grip the bone fixation elements received therein.

13. The system of claim **12**, wherein a first one of the bone fixation elements comprises opposing flattened walls extending along at least a portion of a length thereof.

14. The system of claim **12**, wherein a second one of the bone fixation elements is threaded.

15. The system of claim **14**, wherein the second bone fixation element comprises a plurality of transverse grooves extending substantially parallel to a longitudinal axis of a shaft thereof.

16. The system of claim **14**, wherein the second bone fixation element further comprises a bore extending through a portion thereof to permit insertion of a bone fixation screw therethrough.

17. A method for readjusting a bone fixation element in a bone plate, comprising:

inserting a bone fixation element into a hole extending through a bone plate and into a target portion of bone, the bone fixation element comprising a cavity extending thereinto from a first free end to a second end and a cross bore extending through a portion of the bone fixation element comprising the cavity;

inserting a bolt into the first free end of the cavity, insertion of the bolt applying a compressive force to an insert received within the cavity, wherein the an opening extending through the insert is aligned with the cross bore and insertion of the bolt causes the insert to move from a first unstressed configuration wherein dimensions of the opening are smaller than dimensions of the cross bore to a second stressed configuration wherein dimensions of the opening are increased to the dimensions of the cross bore;

inserting a first bone fixation device through the cross bore so that it passes through the opening of the insert and out of an opposite end of the cross bore; and

loosening the bolt so that the insert is permitted to return to the first unstressed configuration, causing the insert to apply a radially constrictive pressure on the first bone fixation device to lock a position thereof.

18. The method of claim **17**, wherein movement of the insert to the second stressed configuration causes a longitudinal compression and radial expansion thereof.

19. The method of claim **17**, further comprising the step of inserting a second bone fixation device through a bore formed in the first bone fixation device.

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